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Abstract

COMPONENTS FOR SODIUM REACTORS

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Despite the many successes and advances in recent years on sodium system technology, practically every aspect still presents a challenge to the skill and ingenuity, and is amenable to substantial improvement. This paper describes the major components of sodium reactor system - reactor vessels, steam generators, heat exchangers, and pumps - and notes some problems are being worked on.

The United States is fortunate in having been able to gain an appreciable amount of experience with diverse designs of major components in sodium reactor systems since the Second Geneva Conference, 1958. The Hallam Nuclear Power Facility, a 256 MW(th), graphite-moderated sodium reactor, has been tested, commissioned, and operated for months at full power. The Experimental Breeder Reactor II, a 62.5 MW(th) fast breeder, has completed extensive pre-operational testing and has commenced power operation. The Enrico Fermi plant, a 300 MW(th) fast breeder, also has conducted pre-operational testing and is undergoing low-power operation. Smaller and older installations continue to provide information; e.g., Los Alamos Molten Plutonium Reactor Experiment (LAMPRE), Sodium Reactor Experiment (SRE), and EBR-I. In addition, experience to be gained from these systems in the future is expected to be augmented strongly by specific component tests and test programs, some currently in progress, fostered by the U. S. Atomic Energy Commission Sodium Components Development Program.

Emphasis in steam generators and heat exchangers is placed on the design

features employed to prevent contact between sodium and water and to minimize stress corrosion, thermal shock, and vibration. Failures have been experienced with a Hallam intermediate heat exchanger and a Fermi steam generator. One of six Hallam heat exchangers suffered rupture of a tube. The difficulty was traced to tube vibration induced by high velocity of sodium near an inlet. Similar vibration failed several tubes in one of the three Fermi steam ganarators, resulting in a significant sodium-water reaction. Modifications of tube supports and/or flow baffles effectively eliminated the problem. In EBR-II, no difficulty with these components has been experienced to date, but operation has barely started.

None of the vessels has failed or sustained significant difficulty to date. However, only the Hallam unit has yet experienced the principal operating conditions for which it was designed. Of greatest interest at this time are the relative complexities of these vessels, particularly in respect to thermal baffling for prevention of excessive thermal stresses, and the resultant effects upon fabrication effort.

Hallam plant pumps, of the mechanical centrifugal type, have experienced failure or operating difficulty from several causes including accumulation of foreign material within pump wear-ring clearances and misalignment of the pump casing arising from improper temperature distribution. Removal of all six pumps was necessitated for corrective action. Both EBR-II main primary pumps failed during pre-operational testing. Failure in each case was attributed to rubbing between the pump shaft and a "labyrinth seal" provided to restrict flow of sodium vapor along the shaft. Substitution of shafts less susceptible to warpage and of labyrinth seals with greater clearance is thought to have resolved the problem. Centrifugal pumps of the Fermi plant have operated completely satisfactorily for several thousand hours. In all of these plants, the sodium-lubricated (hydrodynamic) bearings of the pumps have been trouble-free.